SECTION 16420
VARIABLE FREQUENCY MOTOR CONTROLLERS

PART I – GENERAL

1.01 SUMMARY OF WORK

A. This section provides specification requirements for adjustable frequency drive, variable speed drives or here in identified (as AC Drives) for use with NEMA B design AC motors.

B. The AC Drive manufacturer shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.

C. Any exceptions/deviations to this specification shall be indicated in writing and submitted with the quotation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Work of the following Sections applies to the Work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this Work.

1. Section 13450: Process Instrumentation, Controls and Monitoring

1.03 REFERENCES

A. Design, manufacturing and assembly of elements of the equipment herein specified shall be accordance with the standards of the below listed organizations. Where reference is made to a standard of one of the following or other organizations, the version of the standard in effect at the time of the bid opening shall apply.

1. American National Standards Institute (ANSI)
2. Acoustical Society of America (ASA)
3. American Society for Testing Materials (ASTM)
4. Electrical Testing Laboratories (ETL)
5. Factory Mutual Insurance Underwriters (FM)
6. Insulated Cable Engineers Association (ICEA)
7. Institute of Electrical and Electronic Engineers (IEEE)
8. Instrument Society of America (ISA)
9. Independent Testing Laboratories (ITL)
10. Joint Industrial Conference (JIC)
11. National Association of Corrosion Engineers (NACE)
12. National Electric Code (NEC)
13. National Electrical Manufacturers Association (NEMA)
14. National Electrical Safety Code (NESC)
15. National Fire Protection Institute (NFPI)
16. Federal Occupational Safety and Health Act (OSHA)
17. Underwriters Laboratories, Inc. (UL)

1.04 SUBMITTALS

A. The following shall be submitted to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01300, Submittals:

1. Shop Drawings:

a. Drawings shall consist of elementary power and control wiring diagrams and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights shown, conduit entrance locations and nameplate legends.

2. Product Data Sheets:

a. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated AC Drive provided.

1.05 QUALITY ASSURANCE

A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.

B. The AC Drive and all associated optional equipment shall be UL Listed according to UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.

C. The AC Drive shall be designed constructed and tested in accordance with NEMA, NEC, VDE, IEC standards.

D. Every power converter shall be tested with an actual ac induction motor, 100% load and temperature cycled within an environmental chamber at 104 degrees Fahrenheit. Documentation shall be furnished to verify successful completion at the request of the engineer.

E. All Drive door mounted pilot devices shall be tested to verify successful operation. Documentation shall be furnished upon written request of the engineer.

F. The AC Drive shall be submitted to a hi-pot test with all enclosed devices mounted and wired, prior to shipment.

1.06 DELIVERY, STORAGE AND HANDLING

A. Storage: Electrical equipment and materials shall be stored in a location and manner to protect against damage.

B. Delivery and Handling: Materials and equipment shall be delivered, unloaded, and handled in a manner to protect against damage. CONTRACTOR shall repair or replace all damaged or defective material at ENGINEER's option and at no cost to the OWNER or ENGINEER.

1.07 WARRANTY

A. A 12-month parts warranty shall be provided on materials and workmanship from the date of invoice from an authorized distributor.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The AC Drive shall be Yaskawa model iQpump 1000 by ICON Technologies.

2.02 GENERAL

A. AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined below.

1. The AC Drive manufacturer shall use a 6-Pulse/12-pulse bridge rectifier design with line reactors (as indicated in the plans), isolation transformers for effective harmonic mitigation. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. The power section shall be insensitive to phase rotation of the AC line.

B. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) or intelligent power modules (IPM) as required by the current rating of the motor. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

2.03 CONSTRUCTION

A. The AC Drive shall be NEMA 12 enclosure.

B. Current-limiting fuses or breakers shall be installed and wired to the AC Drive input.

2.04 MOTOR DATA

A. The AC Drive shall be sized to operate the following AC motor:

1. Motor Horsepower - See listing on plans.
2. Motor full load ampere specify rating coordinated to NEC Table 430-150
3. Motor RPM see as note in plans and specs. at 60 Hz
4. Motor voltage, 480V
5. Motor service factor 1.15

2.05 APPLICATION DATA

A. AC Drive shall be sized to operate the pumps using Variable Torque load drives.

B. The speed range shall be from a minimum speed of 0.5 Hz to a maximum speed of 60 Hz.

2.06 ENVIRONMENTAL RATINGS

A. The AC Drive shall meet IEC 664-1 and NEMA ICS 1 Standards.

B. AC Drive shall be designed to operate in an ambient temperature from 0 to + 40 °C (+32 to 104 °F).

C. Storage temperature range shall be -25 to + 70 °C.

D. Maximum relative humidity shall be 95% at 40 °C, non-condensing.

E. AC Drive shall be rated to operate at altitudes less than or equal to 3,300 ft (1000 m). For altitudes above 3,300 ft, de-rate the AC Drive by 1.2% for every 300 ft (100 m).

F. AC Drive shall meet the IEC 68-2 Operational Vibration Specification.

2.07 RATINGS

A. AC Drive shall be designed to operate from an input voltage of and 480 ± 10% Vac. The drive shall operate from an input voltage frequency range of 60 Hz ± 2%. The displacement power factor shall not be less than .95 lagging under any speed or load condition.

B. The efficiency of the AC Drive at 100% speed and load shall not be less than 96%.

C. Constant torque rated AC Drive over-current capacity shall be 110% for one minute.

D. Output carrier frequency of the AC Drive shall be randomly modulated and selectable at 2, 4, or 10 kHz depending on Drive rating for low noise operation. No AC Drive with an operable carrier frequency above 10 kHz shall be allowed.

E. Output frequency shall be from 0.1 to 400 Hz.

F. AC Drive will be able to develop rated motor torque at 0.5 Hz (60 Hz base) using a standard induction motor without an encoder feedback signal.

2.08 PROTECTION

A. Upon power-up the AC Drive shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.

B. AC Drive shall be UL 508C listed for use on distribution systems with a minimum, 10,000 A, or 22,000 A maximum A RMS available fault current determined available utility fault current. The AC Drive shall have a coordinated short circuit rating designed to UL 508C and NEMA ICS 7.1.09 and listed on the nameplate.

C. Power Converter shall be protected against short circuits, between output phases and ground; and the logic and analog outputs.

D. AC drive shall have a minimum AC under-voltage power loss ride-through of 200 msec. The AC Drive shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the power-loss ride-through.

E. AC drive shall have a selectable ride through function that will allow the logic to maintain control for a minimum of one second without faulting.

F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 5 programmable restart attempts. The programmable time delay before restart attempts will range from 1 second to 600 seconds.

G. Deceleration mode of the AC drive shall be programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop and DC injection braking.

H. Upon loss of the analog process follower reference signal, the AC Drive shall fault and/or operate at a user-defined speed set between software programmed low-speed and high-speed settings.

I. AC drive shall have solid state I2t protection that is UL Listed and meets UL 508C as a Class 10 overload protection and meets IEC 947. The minimum adjustment range shall be from .45 to 1.05% of the current output of the AC Drive.

J. AC Drive shall have a thermal switch with a user selectable pre-alarm that will provide a minimum of 60 seconds delay before over-temperature fault.

K. AC Drive shall use bonded fin heat-sink construction for maximum heat transfer.

L. AC Drive shall have a programmable fold-back function that will anticipate a controller overload condition and fold back the frequency to avoid a fault condition.

M. Output frequency shall be software enabled to fold back when the motor is overloaded.

N. There shall be three skip frequency ranges that can each be programmed with a selectable bandwidth of 2 or 5 Hz. The skip frequencies shall be programmed independently, back to back or overlapping.

2.09 ADJUSTMENTS AND CONFIGURATION

A. AC Drive shall self-configure to the main operating supply voltage and frequency. No operator adjustments will be required.

B. Upon power-up, the AC Drive will automatically send a signal to the connected motor and store the resulting resistance data into memory. The inductance data will be measured during no-load operation when operating at a frequency between 20-60 Hz. The AC Drive will automatically optimize the operating characteristics according to the stored data.

C. AC Drive will be factory pre-set to operate most common applications.

D. A choice of three types of acceleration and deceleration ramps will be available in the AC Drive software; linear, S curve and U curve.

E. Acceleration and deceleration ramp times shall be adjustable from 0.1 to 999.9 seconds.

F. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.

G. The memory shall retain and record run status and fault type of the past eight faults.

H. Slip compensation shall be a software-enabled function.

I. The software shall have a NOLD (no load) function that will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.

J. AC Drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current will be adjustable between 50-150% of rated current and available from 0.0-30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50% of the nameplate current of the motor.

K. Sequencing logic will coordinate the engage and release thresholds and time delays for the sequencing of the AC Drive output, mechanical actuation and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

2.10 OPERATOR INTERFACE

A. The operator interface terminal will offer the modification of AC Drive adjustments via a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics will be in plain English. There will be a standard selection of four additional language built-in to the operating software as standard.

B. The display will be a high-resolution, LCD backlit screen capable of displaying graphics such as bar graphs as well as 6 lines of 21 alphanumeric characters.

C. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall all be listed on the drive identification display as viewed on the LCD display.

D. The display shall be configured for up to two bar-graphs with numeric data selectable and scaleable by the operator. A user defined label function shall be available. As a minimum the selectable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.

E. A single keystroke scrolling function shall allow dynamic switching between display variables.

F. The terminal keypad will consist of programmable function keys. The functions will allow both operating commands and programming options to be preset by the operator. A

hardware selector switch will allow the terminal keypad to be locked out from unauthorized personnel.

G. The operator terminal will offer a general menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock will limit access to the main menu. The main menu will consist of keypad configuration, drive configuration, general configuration, diagnostic mode and drive initialization screens.

H. There will be arrow keys that will provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter. A data entry key will allow the user to confirm a selected menu, numeric value or allow selection between multiple choices.

I. An escape key will allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.

J. A RUN key and a STOP key will command a normal starting and stopping as programmed when the AC Drive is in keypad control mode. The STOP key must be active in all control modes.

K. The keypad and all door mounted controls must be NEMA 12 rated.

2.11 CONTROL

A. Refer to the control schematics in the Contract Plans.

B. All logic connections shall be furnished on terminal strips.

PART 3 – EXECUTION

3.01 PROTECTION

A. Before and during the installation, the AC Drive equipment shall be protected from site contaminants.

3.02 INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

B. The AC Drive manufacturer shall provide a factory certified technical representative to supervise the contractor's installation, testing and start-up of the AC Drive(s) furnished under this specification for 1 day per VFD. The start-up service shall be quoted as a separate line item.

3.03 TRAINING

A. An on-site training course of one (1) training day shall be provided by a representative of the AC Drive manufacturer plant and/or maintenance personnel and quoted as a separate line item.

3.04 WARRANTY

A. The warranty shall be for a minimum of one (1) year starting from the day the VFD is commissioned and accepted by the OWNER.

END OF SECTION